REMARKS

As previously pointed out, the present invention relates to a positive temperature coefficient (PTC) device. Claims 1 and 12 have been amended to explicitly so state.

Also, some of the previous discussion has revolved around the relative density. The point here is that the ceramic is not a sintered material. In that connection, attached hereto for the Examiner's consideration is information which contains a definition of sintering. As will be appreciated, a completed unsintered ceramic has a relative density ratio of 0.5 to 0.6 or less (i.e., 50-60% or less in percentage terms) and as the sintering process proceeds, the relative density is increased to 0.95 (95%) or more. The relative density recitation in the instant claims thus indicates that the channel voids are still present and the ceramic is not fully sintered. To avoid an argument that "about 90%" can be interpreted as including 95%, the term "about" has been deleted. This is the sole reason for that change.

Claims 1-17 were rejected under 35 U.S.C. § 103 over Kumada or under 35 U.S.C. § 103 over Kumada in view of Ogose, Furukawa or Kitsui when considered in combination with Quirk. This rejection is respectfully traversed.

PTC electric components such as thermistors are characterized by a numbers of problems including heat resolution of flux, the oxidation of the ceramic and deterioration in withstand voltage. The present invention is designed particularly to solve the withstand voltage deterioration problem and in order to accomplish that objective, an unsintered ceramic is impregnated with a glass.

The Kumada reference relates to thermoelectric element containing n-type and p-type semiconductive ceramic members provided in the form of plate members which are stacked so as to be interconnected by insulating layers and conductor layers. The insulating layer may be formed of glass. The stacked plate members are heated by a hot plate to be connected with each other under pressure to obtain a laminate which is thereafter sintered. See column 6, line 48 to column 7, line 2.

The Kumada reference fails as anticipation. It does not teach a semiconductive barium titanate impregnated with a glass nor does it teach the ceramic as a relative density of 90% or less. To overcome these deficiencies, the Office Action alleges that "inherently the glass is impregnated since there is pressure and temperature, according to applicant's specification, and bonding would not occur where there is no diffusion. Adhesion requires an amount of diffusion." However, these assertions lack any factual basis and are merely speculation. There is nothing in the applicant's specification which indicates that mere application of pressure and temperature without regard to degree or time will result in impregnation. The specification disclosed impregnation using a solution of the glass. Other methods of achieving impregnation are available but the Examiner has provided no factual basis for one to assume that the mere reference to a hot plate and pressure in Kumada is sufficient to achieve impregnation. At what temperature was the hot plate? Was it above the melting temperature of the glass? What pressure was used? The Kumada reference does not provide answers. As the Examiner is aware, reliance on inherency is improper unless the inherency is certain and it is clearly not certain here. When the laminate is baked, the temperature will likely be above the melting temperature of the glass but that baking procedure forms a sintered ceramic, i.e., a ceramic having a relative density of 95% or more.

The Office Action alleges that Furukawa at column 3, provides evidence that the diffusion occurs by sintering but in that process, the firing was carried out at a temperature of 1000-1300°C whereas the firing in Kumada was at 800°C. Moreover, the ceramic in the present invention is not sintered as established by the recitation of the relative density being 90% or less.

The allegation that "adhesion requires an amount of diffusion" is presented with no factual basis. In the absence of such a basis, the assertion is speculation. Reliance on speculation is, of course, improper. Moreover, while the Kumada reference only indicates that the stacked plate members become "connected", and any such "connection may be at the periphery where there is no glass layer 25.

The foregoing considerations are also relevant under 35 U.S.C. § 103. With reference to the secondary citations, the Furukawa reference relates to an NTC (negative temperature coefficient) thermistor and the Japanese applicants have advised that in the newly cited Kitsui reference, not only is there is no teaching or suggestion of any PTC characteristics nut the green sheet for the thermistor comprises Ni, Mn and Cu which those skilled in this art recognize as a NTC material. The problems of heat resolution of flux and oxidation of ceramics are not problems encountered with an NTC thermistor since the element is not heated or easy to be deoxidized. Being an NTC thermistor, the problem of deterioration in PCT characteristics is not a consideration. Given these considerations, one skilled in the art would not look to these references which teach encapsulation with a glass, even if there is some surface infiltration with the glass, for the purpose of avoiding the deterioration and withstand voltage which is a conventional problem in a PCT element and a focus of the present invention.

The Ogose reference relates to solving a problem of grain boundary insulated multilayer ceramic capacitors exhibiting a high moisture resistance. It does not relate to

a thermistor. To solve the capacitor's high moisture resistance problem, the surface of a sintered compact is coated with a glass paste. It will therefore be appreciated that the glass in this reference is coated on a ceramic having a relative density of 95% or more. Even putting aside the thermistor/capacitor difference, it will be recognized that the instant claims call for diffusion in to a ceramic which has not been sintered while the Ogose teachings at best refer to diffusion into a sintered ceramic.

None of the Kumada, Furukawa, Ogose or Kitsui references teach or suggest impregnating a PCT semiconductive barium titanate which has not been sintered, i.e., having a relative density of 90% or less (rather than the relative density of a sintered material of 95% or more). The Quirk reference does not eliminate this deficiency.

Quirk relates to a method of making an electrical resistance device in which an insulating substrate or surface is provided with a porous electrical resistance coating which is impregnated with a dielectric material to fill its pores. The electrical resistance material can be a fine ceramic ferrite powder or other finely powdered resistive materials such as metal oxides and metal carbides. The spalling problem of such layers is addressed by flame-spraying in such a manner that the layers are porous, i.e., having a relative density of about 93% or less. This permits a high dielectric material such as an epoxy or silicone resin to fill the pores. Nothing in this reference relates to a PTC thermistor or the use of glass in a barium titanate semiconductive PTC ceramic.

Quick teaches that decreasing relative density will increase the size of pores. It will be appreciated that as the pore size increases, this will affect possible current paths and increase the resistance of the material. In using a semiconductive ceramic in a thermistor, an electric current is passed through the ceramic under some conditions and that means that a low resistance value is preferable. To decrease relative density (and increase pore size) is therefore contraindicated in a semiconductive ceramic

thermistor because it will increase resistance. Despite that consideration, the present invention increases pores by employing a ceramic having a relative density of about 90% or less.

It is further respectfully submitted that there is no motivation to combine the references as proposed in the Office Action. The Office Action attempts to provide such motivation by stating in a footnote that it is well known that barium titanate capacitors, resistors and semiconductors differ in whether or not the Ba site is doped and this is asserted to suggest "the compatibility of the two types of electronic devices". In the last response, the Applicants questioned what the term "compatibility" meant in this context but the current Office Action does not explain the point attempted to be made. As pointed out in that last amendment, if what is being asserted is that the problems which are characteristic of PCT semiconducting barium titanate ceramics are necessarily present in barium titanate capacitors and resistors, Applicants respectfully disagree and point out that the additional references cited in the footnote do not support that assertion. If what is being asserted is that any PCT semiconducting barium titanate can be substituted for a different type of barium titanate in capacitors and resistors, Applicants again respectfully disagree and point out that the additional references cited in the footnote do not support that assertion either. Surface coating or surface impregnation a PTC thermistor with glass did not solve the withstand breakdown problem, as noted in the opening paragraphs of the application. Merely surface coating or surface infiltrating an NTC thermistor (Furukawa and Kitsui) or a ceramic capacitor (Ogose) is not the present invention, nor would it suggest the present invention.

For all of the foregoing considerations, it is respectfully submitted that the rejection under 35 U.S.C. § 102 over Kumada or under 35 U.S.C. § 103 over Kumada in view of Ogose or Furukawa or Kitsui in view of Quirk should be withdrawn.

It is respectfully submitted that the present application is now in condition to be allowed and the early issuance of a Notice of Allowance is respectfully solicited.

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Respectfully submitted,

By 

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